BLOOD LACTATE LEVELS DURING A COMBINED WATER-BASED EXERCISE TEST IN ELITE LIFESAVING ATHLETES

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ABSTRACT

BLOOD LACTATE LEVELS DURING A COMBINED WATER-BASED EXERCISE TEST IN ELITE LIFESAVING ATHLETES. V. Alfaro, L. Palacios, R. Torras. JEPonline. 2002;5(1):1-4. Blood lactate (La) levels were analysed during a combined exercise test in elite lifesaving athletes, which included 50 m freestyle swimming at maximal effort, 15-20 m underwater swimming, and 30 m dragging of a mannequin simulating a drowned person. Swimming resulted in increased blood La to a level close to the onset of blood La accumulation (3.6±0.9 and 4.6±1.4 mmol/L for men and women, respectively). However, after further underwater swimming blood La did not increase significantly. Finally, after the completion of the combined test higher blood La values (12.7±2.5 and 11.6±2.7 mmol/L for men and women, respectively) were found. These findings suggest that during the intermediate phase of underwater swimming the duration was short enough, and the exercise intensity low enough, for the energy required to be obtained from aerobic sources. Nevertheless, a transient hypercapnia may have occurred, causing the retention of La in the intracellular compartment. However, increased ventilation in the last part of the test in addition to a strong anaerobic effort when dragging the mannequin may lead to the higher La values found at the completion of the trial. More research is required of the metabolic and physiological demands of lifesaving.

Key Words: Performance, Physical Fitness, Hypercapnia, Hypoxia

INTRODUCTION

Several studies have been performed on adaptation to exercise in athletes during the performance of different aquatic sports, including swimming (1), swimming during triathlon races (2), synchronized swimming (3), breath-hold diving (4) and water polo (5). However, to our knowledge no information has been provided about blood lactate levels during the exercise tests usually performed by elite lifesaving athletes. In competitive lifesaving, the contestants are required to perform different series of exercise trials, but the most characteristic of this peculiar sport is a combined test which includes consecutive bouts of swimming, underwater swimming and dragging of a mannequin. Lifesaving is a sport in which increased metabolic demands are required in a short-term, always less than 2 minutes. Indeed, this combined test is the trial that best reflects the work involved in emergency lifesaving.
The aim of the present study was to examine the changes in blood lactate (La) levels in elite lifesaving athletes during the combined exercise test. As blood La determination is a tool routinely used in the science of coaching, the present data may be of help in designing training programs for lifesaving athletes.

METHODS

The subjects who volunteered for this study were five men and five women from the Spanish Lifesaving Team and the analyses were performed during the 1994 European Lifesaving Championship. The characteristics of the subjects are presented in Table 1. All tests were performed under close clinical supervision, and the subjects were fully informed of the purpose of this study and possible risks before signing the informed consent form in accordance with the recommendations of the Declaration of Helsinki.

Baseline La measurements were taken prior to the beginning of each phase to check an adequate recovery (6). Blood samples (20 µl) were taken from the earlobe 3 and 5 min after each test. The samples were pipetted into chilled tubes containing 0.6 N perchloric acid solution and centrifuged. Blood samples were analysed as previously described (7). Statistical significance was assessed using an analysis of variance (ANOVA) with repeated measures. The Student-Newman-Keuls test was performed for post-hoc analyses. Results were considered significant at the p<0.05 level, and data are expressed as means±SD.

RESULTS

Time records between series were uniform and reproducible. Mean velocities and time records for the three parts of the combined test are shown in Table 2. These data reflected that both underwater swimming and further dragging of the mannequin decelerated the athletes with respect to the first part of the test. Figure 1 shows the blood La levels found during the combined exercise test. Blood La concentration measured after the first 50 m of swimming (part 1) was not significantly different from that measured after 50 m swimming and further 15-20 m underwater swimming (part 1 plus part 2). However, the blood La concentration after the in-water mannequin drag was notably higher.
Table 2. Time and velocities of performance for parts of the combined test.

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<tr>
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<th>Part 1</th>
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<th>Part 2</th>
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<th>Part 3</th>
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<td></td>
<td>s</td>
<td>v, m/s</td>
<td>s</td>
<td>v, m/s</td>
<td>min’s</td>
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<tr>
<td>Men</td>
<td>29.34±1.57</td>
<td>1.704±0.032</td>
<td>47.31±0.56</td>
<td>1.479±0.025</td>
<td>1’16.27 ±1.10</td>
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<tr>
<td>Women</td>
<td>32.95±2.20</td>
<td>1.517±0.046</td>
<td>49.00±2.54</td>
<td>1.326±0.043</td>
<td>1’30.08 ±1.09</td>
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DISCUSSION
The mean velocities found during the first 50 m of freestyle swimming in lifesaving athletes were similar to the mean velocity found in other studies on swimming (1,5). Blood La values found in this first part of the combined test were around the onset of blood lactate accumulation (OBLA, 4 mmol/L). Diverse investigators have used the OBLA as a useful and important index for estimating the swimming endurance performance. Thus, the exercise intensity corresponding to OBLA has been used as the optimum swimming training intensity (8-10). However, an unexpected finding was that after additional 15-20 m of underwater swimming blood La levels did not significantly change. This means that the energy required during the intermediate phase could be obtained from aerobic sources, which may be favoured first by the decrease in the exercise intensity during underwater swimming, and second by improved O2 release to the tissue on this condition (11).

Nevertheless, lactate retention in the muscular compartment during this intermediate part of the combined test should not be disregarded. Indeed, significant hypercapnia has been found in synchronised swimmers (3) and rats (12) during short periods of underwater swimming. Blood La is decreased at high workloads after inhalation of hypercapnic gas mixtures simulating respiratory acidosis (13). This La decrease in blood has been attributed both to a direct effect on intracellular pH and the regulation of key glycolytic enzymes and/or the influence of extracellular pH on the release of La from intra- to extracellular fluid (13). In the present study, although not evaluated, the underwater swimming during part 2 was an intermediate phase of exercise with apnoea. Consequently, the apnoea together with the CO2 generated by proton buffering from the metabolic acidosis incurred during the initial 50 m swimming may contribute to increase the blood PCO2. However, hypercapnia may be reduced in the part 3 of the combined test by increased ventilation. Therefore, a transient respiratory acidosis developed during underwater swimming in the intermediate part of the combined test may contribute to the retention of La in the intracellular compartment, but La efflux from intra- to extracellular compartment would increase in the last part of the combined test.
Finally, significant increases in blood La concentration were found at the completion of the third part. Thus, the dragging of the mannequin simulating the drowned person was an intense task, requiring an increased dependence on anaerobic metabolism.

In conclusion, the present study provides evidence of the extent to which an important anaerobic component may be present in these characteristic trials. Thus, we believe that the present data may be of use in the training of lifesaving athletes.

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REFERENCES